Modelling the relationship between learner autonomy and cognitive abilities – worth the effort?

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ABSTRACT
More and more schools recognize that as nobody knows what the world will look like in the future and what skills we will need, it is necessary to teach children how they can learn effectively and on their own throughout life, i.e. to develop their learner autonomy. However, despite its importance, little research has been dedicated to exploring the relationship between learner autonomy and other domains, such as cognitive skills. Therefore, this paper models the relationship between the level of learner autonomy and percentiles obtained in standardized tests in the Czech language and Math in a group of third-graders and fifth-graders in an attempt to find out whether and how the learner autonomy is related to other skills taught at schools.

CCS Concepts
• Social and professional Topics → Computing education→ Computing education programs → Student assessment

Keywords
learner autonomy; cognitive skills, Czech language, Math; primary schools, learning analytics; student assessment;

1. INTRODUCTION
Learner autonomy has recently become a buzz word among teachers as many of them have realized that it is not sufficient to teach children specific knowledge and to make them memorize facts, because these may soon become outdated. The world keeps changing fast – what is true today may be proven wrong tomorrow, skills that are needed today may not be needed in 5 years' time. Therefore, a priority should be given to teaching children how to learn new skills themselves, i.e. to develop their learner autonomy. The ability to learn is one of the few skills which are certainly going to be needed in the future no matter what the world will look like and having a high level of learner autonomy may help children acquire new knowledge and skills faster and more easily. Furthermore, learner autonomy is likely to be one of the few skills that are easily transferable from one domain to another – a person with a high level of learner autonomy will probably find this ability useful no matter if he or she is a teacher, a scientist, a translator or a painter.

However, although teachers may help every child increase his/her level of learner autonomy, there might be a difference in the highest possible level of learner autonomy a person can acquire. So far, little research has been dedicated to answering the question of what factors may be underlying people's predispositions to achieve a high level of learner autonomy. As this is a very complex question, this paper only focuses on the relationship between learner autonomy and cognitive skills, trying to answer the question of how the level of learner autonomy depends on results obtained in the tests of the Czech language and Math.

First, learner autonomy is going to be defined in more detail. Second, data acquired thanks to the learning analytics tools developed within the LEA's Box project are going to be presented with the aim to explore the relationship between learner autonomy and cognitive skills. Finally, suggestions for further research questions are going to be presented.

2. LEARNER AUTONOMY
Learner autonomy is a very complex concept whose definition differs from domain to domain, from scientist to scientist and from teacher to teacher. We may assume that children with a high level of learner autonomy display the ability and willingness to take responsibility for their own process of learning, but such a definition is rather vague.

Each researcher focuses on slightly different aspects of learner autonomy. For example, Benson (2001) emphasizes the fact that children's ability to increase their level of learner autonomy depends, to a great extent, on teachers' ability to guide them through the process of becoming autonomous, while Tarone and Yule (1989) stress out that one of the most critical aspects of learner autonomy is the ability to deal with mistakes that invariably occur in each process of learning.

The concept of learner autonomy has been explored mostly in the context of language learning, probably because learning a language requires in general a higher amount of self-study time compared to other skills. For example, Omaggio (1978) believes there are seven main attributes of learner autonomy when learning a new language: having insights into learning styles and strategies, taking an active approach to the task at hand, willingness to take risks, being a good guesser, placing importance on both form and content, willingness to revise and rejects rules that do not apply and having a tolerant and outgoing approach to the target language.

Another important question is whether learner autonomy is a purely Western construct. Children in tribal communities or less developed societies live in conditions which are more or less stable throughout their life and they acquire most of what they need for survival very naturally, because it is easy for them to see the importance of such skills. By comparison, children in Western societies often face a situation when they need to learn something they do not immediately need or something that takes years to acquire, such as a foreign language, mathematics or physics. A higher level of reflection over the process of learning and more long-term thinking is therefore required, both of which are undoubtedly related to the concept of learner autonomy.

Due to the lack of universal definition of learner autonomy, a new definition has been made for the purpose of this paper and further research. Learner autonomy has been defined as a concept consisting of seven domains.

1. The ability to set meaningful and achievable goals: this means a child is able set long-term and short-term goals and evaluate whether they are attainable and realistic.
2. The ability to find ways to reach a goal: this means a child is able to determine several possible strategies to reach a goal and pick up the most appropriate one, can make a realistic estimate of the time and effort needed to reach a goal and has a good sense of how tasks and activities depend on each other.
3. The ability to identify a source of failure: this means that in the case of failure, a child is able to explain what went wrong, and can distinguish between what was caused by him/her and what was caused by external factors.
4. The ability to learn from one's mistakes: this means a child avoids past mistakes and is able to anticipate possible future mistakes and take appropriate measures.
5. The ability to perceive mistakes as an opportunity for improvement: this means a child does not become frustrated by mistakes but rather perceives them as a source of new knowledge and experience and tries to improve.
6. The ability to work independently towards reaching a goal: this means that a child can independently work towards reaching a goal, can handle distractions and has an age-appropriate attention span.
7. The ability to evaluate if a goal has been reached: this means that a child can determine if a task has been successfully completed and alternatively come up with ideas how to complete it.

3. CASE STUDY

3.1 Aim of the study

The aim of the study presented in this paper is to determine whether there is any relationship between the level of learner autonomy, as described above, and cognitive abilities as measured by standardized tests.

Most teachers acknowledge that cognitive abilities vary among children and that they are, to a certain extent, hereditary, while at the same time it is often taken for granted that the ability to achieve a high level of learner autonomy is universal. However, should these two be related, teachers might need to accept the fact that for some children, the ability to achieve a high level of learner autonomy is limited or, at least, that it may cost them more effort to achieve a desired level or learner autonomy compared to children who are naturally gifted in this aspect.

3.2 Data

The data comes from a pilot study conducted in June 2016 as a part of the LEA's Box project. This project is focused on aggregating and visualizing data from different sources in order to allow teachers to make more competent decisions about their students' learning process.

One of the main benefits of LEA's Box for teachers is a tool which allows for a comparison of self-assessment, teacher's assessment and standardized assessment. In the pilot study, self-assessment was omitted, but it is going to form part of the next study which is to be conducted in September. Therefore, data collected in June 2016 only come from two sources: standardized tests and teacher's assessment. The standardized tests measured children's knowledge and abilities in the Czech language and Math and the results are in the form of percentiles. As for teacher's assessment, this focused on learner autonomy and was done using a table containing a 4-point scale (0 to 3) for each of the seven domains described in the previous section. For each domain, there was a description of what behaviour it is possible to observe at a child at different levels. The teacher's task was to assign each child with a number from 0 to 3, where 0 means the child performs poorly in that particular domain while 3 means the child performs exceptionally. For the final "autonomy score" the seven numbers were simply summed, therefore it was possible to obtain a score ranging from 0 to 21.

Altogether, the data contains values for 62 children: 29 attending the third grade, which, in the Czech educational system, corresponds to ages of 8 to 9, and 33 attending the fifth grade, which corresponds to ages 10 to 11.

All of them were evaluated by the same learner autonomy questionnaire. As for the standardized tests, 28 third-graders and 33 fifth-graders took a test in the Czech language while 26 third-graders and 18 fifth-graders took a test in Math, these two tests being different for each grade and testing age-appropriate skills (see Table 1 for a summary of the number of study subjects).

Table 1. Number of children evaluated in different subjects

Grade	autonomy	Czech	Math
third	29	28	26
fifth	33	33	18

Table 2 shows average values or learner autonomy score in the third and fifth grade for each of the seven domains described above. It can be seen that fifth-graders achieved a higher score at every single domain compared to third-graders. The smallest difference can be seen in domain 2, the ability to find ways to reach a goal, while the largest difference can be seen at domain 6, the ability to work independently towards reaching a goal, suggesting that younger children may still rely more on being "pushed" while working or studying.

Table 2. Average score in each of the seven domains of learner autonomy

Grade	1	2	3	4	5	6	7	Total
Third	1,38	1,17	1,28	0,86	1,28	1,10	1,38	8,45
Fifth	1,52	1,24	1,58	1,15	1,33	1,45	1,64	9,91

3.3 Results

Let us now explore the relationship between the level of learner autonomy and percentiles in the Czech language and Math standardized tests.

Table 3 shows correlations between the percentiles obtained in the Czech and Math tests (the group – third or fifth grade – being denoted by the number in brackets) with each of the seven domains of learner autonomy as well as with the total "autonomy score".

Table 3: Correlation of tests results and learner autonomy points

Correlation	1	2	3	4	5	6	7	Total
Czech (3)	0.34	0.41	0.52	0.42	0.34	0.26	0.42	0.45
Czech (5)	0.59	0.52	0.66	0.64	0.51	0.74	0.67	0.69
Math (3)	0.39	0.37	0.55	0.53	0.33	0.44	0.42	0.50
Math (5)	0.28	0.29	0.63	0.42	0.61	0.46	0.52	0.53

The correlation coefficients vary for grades, subjects and domains, but there is undeniably a strong positive relationship between what is measured by standardized tests in the Czech language and Math and what is evaluated in the learner autonomy questionnaire.

The highest correlations can be seen in domain 3 (the ability to identify a source of failure), 4 (the ability to learn from one's mistakes) and 7 (the ability to evaluate if a goal has been reached), although there is also a particularly high correlation between the fifth graders' results in the Czech language test and their results in domain 6 (the ability to work independently towards reaching a goal). A possible explanation may be that these domains require a higher level of cognitive and metacognitive skills which are also necessary in cognitive-based tests. In comparison, domains 1 (the ability to set meaningful and achievable goals) and 2 (the ability to find ways to reach a goal), where the correlations seem to be lower, may be more related to a child's personality and motivation (note that it may be difficult to differentiate between a child's ability to set goals and ways to reach them and his/her willingness to do so). Domain 5 (the ability to perceive mistakes as an opportunity for improvement) may be more related to personality as well, even though the correlations here are quite high for five-graders, suggesting that those who see mistakes as a source of improvement may make more progress in cognitive-based domains over the course of time and thus subsequently outperform those who score lower in this domain. A similar assumption may hold true for domain 6 (the ability to work independently towards reaching a goal), which is, once again, somewhat related to personality and one's level of self-control: those who score high in this domain may make more significant progress over the course of time compared to those with a low score, which may explain why the correlations here are higher in the older group.

Let us now explore graphs depicting the relationships under scrutiny. Figure 1 shows, for each grade and subject, the relationship between the total number of points obtained in the learner autonomy evaluation (0 to 21) and the percentiles obtained in the standardized tests. The relationships appear to be linear, therefore, we ran a simple linear regression with percentiles being the dependent variable and autonomy scores being the explanatory variable. Then, the resulting regression lines have been added to the graphs, with the following coefficients:

$$3^{rd}\ grade, Czech: \widehat{percentile} = 32.55 + 2.34 \cdot autonomy\_points$$

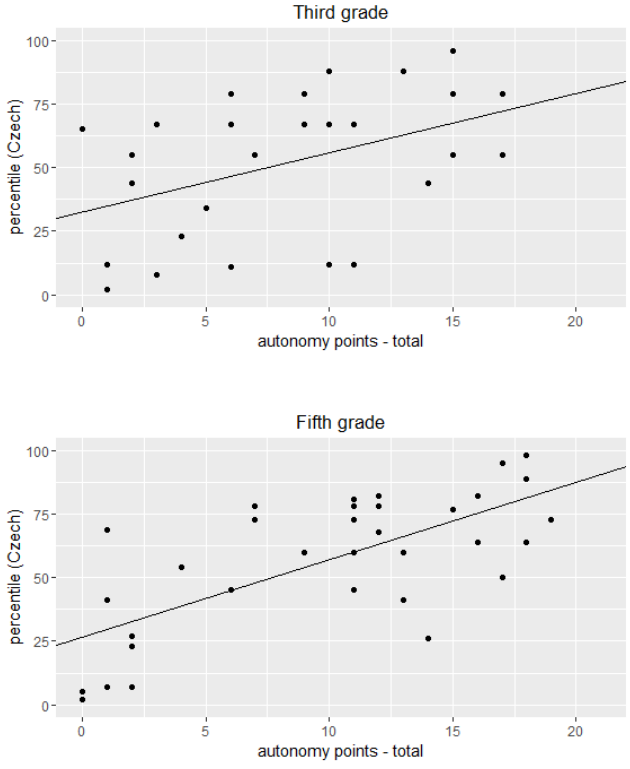
$$5^{th}\ grade, Czech: \widehat{percentile} = 26.76 + 3.03 \cdot autonomy\_points$$

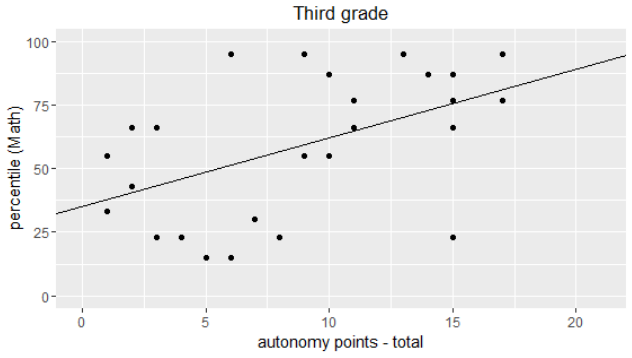
$$3^{rd}\ grade, Math: \widehat{percentile} = 35.09 + 2.69 \cdot autonomy\_points$$

$$5^{th}\ grade, Math: \widehat{percentile} = 22.94 + 2.56 \cdot autonomy\_points$$

All slope coefficients are statistically significant (p-value < 0.05). The regression coefficients suggest that, ceteris paribus, for each increase in the learner autonomy score by one point, there is, on average, a two to three percentile increase in the results obtained in the cognitive tests, depending on grade and subject.

Figure 1: relationships between the total number of autonomy points and percentiles for different grades and subjects





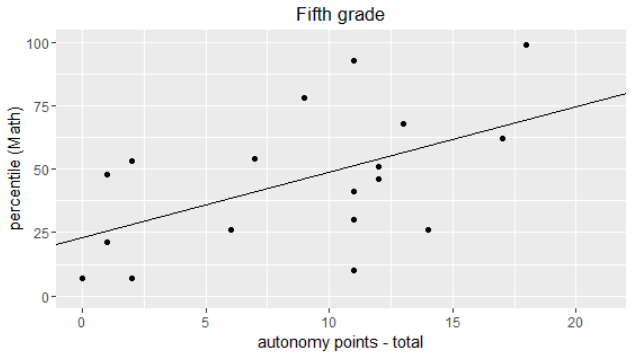


Table 4 shows regression coefficients for each of the seven domains of learner autonomy separately, i.e. the relationship between the number of points obtained in a particular domain (explanatory variable) and the percentile obtained in the standardized test (dependent variable), with bold values representing statistically significant parameters (p-value < 0.05). This time, the values of explanatory variables only range from 0 to 3, so the slope coefficients associated with a 1-point increase are higher. The highest slope coefficient is 23.13 (fifth grade, Czech language, domain 4), suggesting that in the older group, a 1-point increase in this domain is, ceteris paribus, associated with, on average, a 23.13 percentile increase in the percentile obtained in the Czech language test.

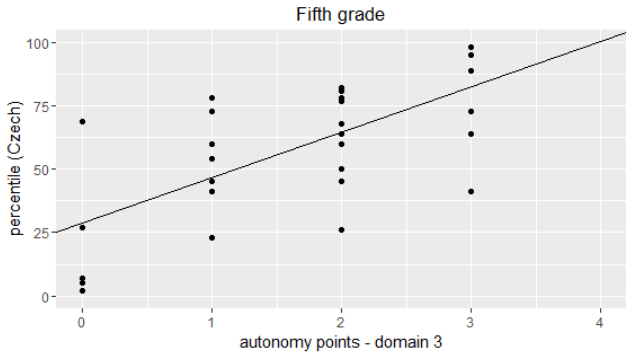
Table 4: Coefficients of regressions lines with individual learner autonomy domains as explanatory variables

dep.variable	domain (explanatory variable)						
Czech (3)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
intercept	**38.69**	**37.27**	**32.46**	**38.89**	**36.60**	**43.44**	**33.93**
slope	9.78	**12.77**	**15.45**	**15.05**	12.57	8.03	**13.55**
Czech (5)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
intercept	**35.17**	**38.66**	**28.58**	**30.19**	**36.23**	**28.45**	**30.12**
slope	**14.29**	**14.62**	**17.92**	**23.13**	**15.43**	**19.50**	**16.32**
Math (3)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
intercept	**42.07**	**44.71**	**36.56**	**41.70**	**42.53**	**43.55**	**39.25**
slope	11.46	11.46	**16.53**	**19.34**	12.45	**13.22**	**13.74**
Math (5)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
intercept	**35.36**	**35.90**	**22.30**	**28.81**	**22.75**	**27.71**	**24.51**
slope	7.65	9.15	**16.75**	**16.75**	**19.55**	12.85	**14.57**

For the domains which have been previously said to be possibly dependent on personality rather than on one's level of cognitive skills, the slope coefficients have in some cases not proven to be statistically significant.

As an example, figure 2 shows a graphical representation of the relationship between the results in the Czech language test and the number of points obtained in domain 3 (the ability to identify a source of failure).

Figure 2: relationship between the number of autonomy points obtained in domain 3 and percentile obtained in the Czech language test



4. DISCUSSION

4.1 Summary

This study explored the relationship between the level of learner autonomy as defined in the second section of this paper and the results obtained in standardized tests in two different subjects, the Czech language and Math. The children evaluated for the purpose of this study comprised third graders and fifth graders.

It has been shown there is a significant relationship between these two variables regardless of grade and subject. When split into individual domains, it was shown that the relationship between learner autonomy and the results in cognitive tests is stronger for some domains than for others, possibly because some domains require a higher level of cognitive and metacognitive skills (e.g. the ability to analyze a source of error or the ability to evaluate if a goal has been reached), while others may be more related to motivation or certain aspects of personality (resilience, self-control etc.).

However, one should interpret the results presented in this paper with care. It is not possible to say that a high level of learner autonomy leads to a high level of cognitive skills or vice versa – the causal relationship between these two variables is unclear and both of them may be strongly influenced by an entirely different variable.

In any case, when trying to increase a child's level of learner autonomy, which is a trend in many schools, it is necessary to take into account the child's level of cognitive development and to realize that these two may be related.

4.2 Limitations

As this was a pilot study, not too much data was available. Also, the results of this study are limited to only two age groups and two subjects (the Czech language and Math).

Another important limitation is the definition of learner autonomy itself. The definition suggested in this paper is not universal – each researcher or psychologist may define it in a different way, depending on what they consider to be a priority and what their goal is. When defining the concept of learner autonomy, it is crucial to choose such domains/aspects that are easily describable and observable and simple to evaluate, yet that cover all parts of learner autonomy deemed important, which is not an easy task. Furthermore, evaluating the level of learner autonomy may also be challenging for teachers as it is always somewhat subjective.

4.3 Suggestions for further research

As mentioned above, this study was limited to a handful of subjects and age groups. It would be especially beneficial to explore the relationship of learner autonomy with the results of scholastic aptitude tests (such as SAT) or IQ tests, and with the results of personality tests. It would also be useful to extend the research to more age groups and to include self-assessment.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Benson, P., 2001. Teaching and researching learner autonomy. *Harlow: Pearson Education*.

[2] Omaggio, A.C., 1978. Successful language learners: What do we know about them. *ERIC/CLL News Bulletin*, *5*, pp.2-3.

[3] Tarone, E., Yule, G. and Yule, G., 1989. Focus on the language learner: Approaches to identifying and meeting the needs of second language learners (pp. 34-39). Oxford: Oxford University Press.